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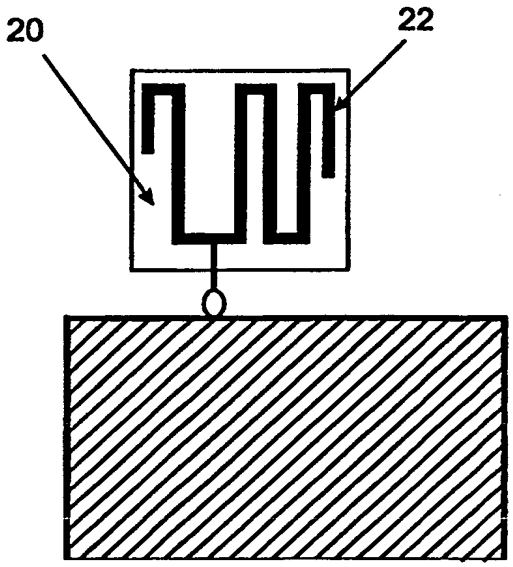
(54) Title: MULTIPLE BAND, MULTIPLE BRANCH ANTENNA FOR MOBILE PHONE

(57) Abstract

A multiple band antenna having multiple branches, each branch having a length and geometry selected to resonate in a particular frequency band. Each branch can be formed by a flexible film which has a meandering strip line pattern formed thereon and which is formed into a desired shape. Each branch can also be formed by etching a strip line to a member of a desired shape. The strip line pattern is preferably formed by printing so as to avoid mechanical tolerance problems.



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MULTIPLE BAND, MULTIPLE BRANCH ANTENNA FOR MOBILE PHONE

Field of the Invention

The present invention relates generally to antennas for mobile communication devices. More particularly, the present invention relates to a multiple band, multiple branch antenna.

Background of the Invention

Because there are many different types of communication systems, such as GSM, DCS, PCS, DAMPS, and others, it is increasingly possible to have different types of systems serving a common area. These systems typically operate at different frequency ranges, e.g. GSM typically operates at 890-960 MHZ and DCS typically operates at 1710-1880 MHZ. In the future, it may be desirable to introduce any of a number of functions such as home based wireless phone, mini data link, wireless hands free set, etc. to a mobile telephone. For these reasons, a multiple mode antenna (that is, an antenna which can resonate at different frequency to allow a communication device to operate in multiple bands) is highly desirable.

Some dual band antenna designs are known. The Japanese patent (6-37531) discloses a helix which contains an inner parasitic metal rod. In this antenna, the antenna can be tuned to dual resonant frequencies by adjusting the position of the metal rod. Unfortunately, the band width for this design is too narrow for use in cellular communications. Dual band printed monopole antennas are known in which dual resonance is achieve by the addition of a parasitic strip in close proximity to a printed monopole antenna. While such an antenna has enough bandwidth for cellular communication, it requires the addition of a parasitic strip. Moteco AB in Sweden has designed a coil matching dual band whip antenna and coil antenna, in which dual resonance is achieve by adjusting the coil matching component (¼ λ for

900 MHZ and ½ λ for 1800 MHZ). While this antenna has relatively good band width and radiation performances, its length is only about 40mm. A non uniform helical dual band antenna which is relatively small in size is disclosed in Applicant's copending , commonly assigned application entitled "Multiple Band Non-Uniform Helical Antennas", serial number 08/725,507, the entirety of which is incorporated by reference.

It is known that an extended whip antenna has a higher efficiency when the phone is relatively close to a human head. Typical dual band extendable whip antennas, such as those mentioned above, require a complicated matching network to match the whip antenna impedance to the two bands within 50 ohms. A dual band retractable antenna is disclosed in Applicant's copending, commonly assigned application entitled "Retractable Multi-Band Antennas", serial number 08/725,504, the entirety which is incorporated by reference. Such an antenna requires two ports, one for a helical antenna and another for a whip antenna. A means for switching between the ports for the different modes is required.

It would be desirable for a multiple mode portable communication device to have an efficient multiple band antenna. Conventional dual band helical antennas such as those described above have certain disadvantages. For example, mechanical production tolerances can change the resonant frequencies, particularly at higher bands. Also, it can be relatively difficult to provide a sufficient coupling for dual band parasitic coupling extendable antennas because the distance between a base antenna and the extendable whip can be different at different bands.

Summary of the Invention

The present invention overcomes the above-described problems, and achieves additional advantages, by providing a multiple band, multiple branch antenna which can be tuned to multiple resonant frequencies. The multiple resonances for the antenna (corresponding to, for example, GSM, DCS or PCS) are achieved by providing variations in the printed pattern of the antenna

branches. Each branch of the antenna can be printed on a relatively thin plastic film, and can be rolled into a cylinder shape. Alternatively, the branches can be formed by etching patterns on a plastic member having a cylindrical or other suitable shape.

The multiple branch antenna of the present invention achieves resonance at different frequencies without a matching network. If the antenna branches are formed by printing, mechanical tolerance problems are avoided. The geometries of the branches can be varied to allow increased design freedom.

Brief Description of the Drawings

The features and advantages of the present invention will be more fully understood upon reading the following Detailed Description of the Preferred Embodiments in conjunction with the accompanying drawings, in which like reference indicia designate like elements, and in which:

FIG. 1 is a diagram showing a multiple branch antenna implementing the principles of the present invention;

FIG. 2 is a diagram of a printed antenna branch according to an embodiment of the present invention;

FIG. 3 is a diagram showing a method for manufacturing an antenna according to the present invention; and

FIG. 4 is a graphical representation of measured return loss for an antenna assembly including a multiple branch antenna according to the invention.

Detailed Description of the Preferred Embodiments

A central principle of the present invention is that different branches of the multiple band antenna are resonant at different frequencies. This principle is represented in FIG. 1, which shows a multiple branch antenna having first and second branches 10 and 12. The antenna branches are connected to a common port 14 for exchanging signals between the antenna branches and the transceiver

circuitry of a portable communications device 16. The first branch 10 is of a length and construction so as to be resonant at frequencies in a first band, and the second branch 12 is of a length and construction so as to be resonant at frequencies in a second band. According to a preferred embodiment of the present invention, the first band is the GSM band and the second band is the DCS band. In such an embodiment, the first branch 10 is approximately 1/4 wavelength of a GSM signal, and the second branch 12 is approximately 1/4 wavelength of a DCS signal. The antenna is tuned, for example at the time of manufacture, to an impedance of approximately 50 Ω for both bands. If the antenna is so tuned, no impedance matching circuitry is required between the antenna and the port 14.

Referring now to FIG. 2, an exemplary antenna branch according to an embodiment of the invention is shown. The antenna branch is comprised of a relatively thin, flexible dielectric film 20 and a strip antenna formed by a meandering metal line 22. The metal line can be formed by printing, etching, or other suitable method. Because the film is a flexible material, the printed film can be rolled into a generally cylindrical shape for use as an antenna branch, as shown in FIG. 3. It should be appreciated that the cylinder could be partially open or completely closed depending upon antenna design considerations. For example, the bandwidth of the antenna can be varied by varying the diameter of the cylinder. Of course, it should be appreciated that the antenna branches can be formed in shapes other than a cylinder, and different branches can have different geometries (for example, elliptical), depending upon design considerations. The metal line 22 can also be etched directly onto a dielectric cylinder. The use of different geometries and manufacturing methods allow increased design freedom.

The meandering metal line 22 is preferably varied between the antenna branches such that the different antenna branches are resonant at different frequencies. Thus, multiple resonances in multiple branches can be achieved by selecting appropriate strip dimensions and patterns for each branch.

The antenna branches are similar to monopole antennas, and have relatively high efficiency when used in a portable, hand-held communication device such as a mobile telephone. The dual resonances of a typical dual band helical antenna are achieved by changing pitch angle or other helical parameters. Because the resonant frequencies in a helical antenna will also be dependent upon the mechanical tolerances of the helical parameters, the multiple branch antenna of the present invention provides a significant advantage. More particularly, the printed multiple branch antenna according to the present invention significantly reduces the likelihood of mechanical tolerance problems because the height of the antenna can be easily adjusted by changing the strip line pattern or dimensions.

The antenna of the present invention is particularly suitable as a multiple mode base antenna for the parasitic extendable dual band antenna disclosed in Applicant's copending, commonly-assigned application entitled "Multiple Band Telescope Type Antenna for Mobile Phone", the entirety of which is incorporated by reference. When used as a base antenna in cooperation with a whip antenna, the multiple mode, multiple branch antenna of the present invention allows the coupling distance between whip antenna and the base antenna to be easily adjusted. This provides a significant advantage over known dual band helical antennas.

Referring now to FIG. 4, a graphical representation of measured return loss for an antenna assembly including a multiple band, multiple branch antenna according to the present invention is shown. In this example, the plastic film is bent into a substantially circular cylinder which is approximately 25mm in length and approximately 9mm in diameter. FIG. 4 shows the return loss in dB for different frequencies. The diagram indicates a first peak corresponding tot he GSM frequency band, a second peak corresponding to the DCS frequency band, and a third, shallower peak corresponding to the PCS frequency band. It will be appreciated that a suitable antenna according to the present invention can be designed to operate in two or more bands corresponding to GSM, DCS, PCS, or

other frequency bands. Radiation pattern tests of the antenna according to the present invention show that the antenna achieves performance similar to a helical antenna, but the with a broader band width.

While the foregoing description includes numerous details which are provided for instructional and explanatory purposes only. The specific examples discussed above are not to be construed as suggesting limitations of the invention; rather, these examples can be modified in many ways without departing from the scope of the invention, as defined by the following claims and their legal equivalents.

WHAT IS CLAIMED IS:

1. A multiple band, multiple branch antenna, comprising:

a first branch having a first length and first cross-sectional geometry for resonating at a first frequency; and

a second branch having a second length and second cross-sectional geometry for resonating at a second frequency.

2. The antenna of claim 1, wherein each branch includes a flexible dielectric film having a different metal strip line pattern formed thereon.

3. The antenna of claim 2, wherein the metal strip line pattern is formed by printing.

4. The antenna of claim 2, wherein the metal strip line pattern is formed by etching.

5. The antenna of claim 1, wherein each branch is formed by etching metal strip line patterns onto a dielectric member.

6. The antenna of claim 2, wherein the first and second branches each have lengths corresponding to one of the GSM frequency band, the DCS frequency band, and the PCS frequency band.

7. The antenna of claim 2, wherein the first and second cross-sectional geometries are substantially similar.

8. The antenna of claim 7, wherein the first and second cross-sectional geometries are substantially cylindrical, and have diameters selected to achieve a desired bandwidth and size.

9. The antenna of claim 1, wherein first and second branches are tuned to a common impedance.

10. The antenna of claim 5, wherein the dielectric member has a substantially cylindrical geometry.

11. A multiple mode, hand held, portable communication device, comprising:

transceiver circuitry for exchanging communication signals in multiple modes; and

a single port for interfacing between the transceiver circuitry and a multiple mode antenna, the multiple mode antenna having a first branch having a first length and first cross-sectional geometry for resonating at a first frequency in a first mode, and a second branch having a second length and second cross-sectional geometry for resonating at a second frequency in a second mode.

12. The device of claim 11, wherein each branch includes a flexible dielectric film having a different metal strip line pattern formed thereon.

13. The device of claim 12, wherein the metal strip line pattern is formed by printing.

14. The device of claim 12, wherein the metal strip line pattern is formed by etching.

15. The device of claim 11, wherein each branch is formed by etching metal strip line patterns onto a dielectric member.

16. The device of claim 12, wherein the first and second modes are GSM and DCS, and the first and second branches have lengths corresponding to the GSM frequency band and the DCS frequency band, respectively.

17. The device of claim 12, wherein the first and second cross-sectional geometries are substantially similar.

18. The device of claim 17, wherein the first and second cross-sectional geometries are substantially cylindrical, and have diameters selected to achieve a desired bandwidth and size.

19. The device of claim 11, wherein first and second branches are tuned to a common impedance such that there are no separate impedance matching networks between the single port and the first and second branches.

20. The device of claim 15, wherein the dielectric member has a substantially cylindrical geometry.

FIG. 1

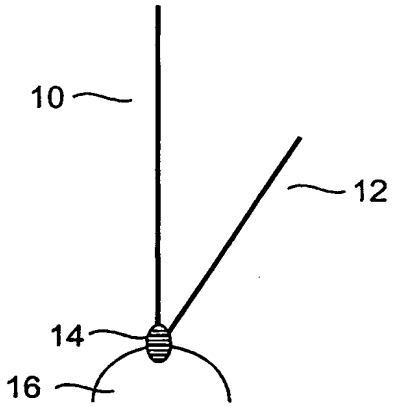


FIG. 2

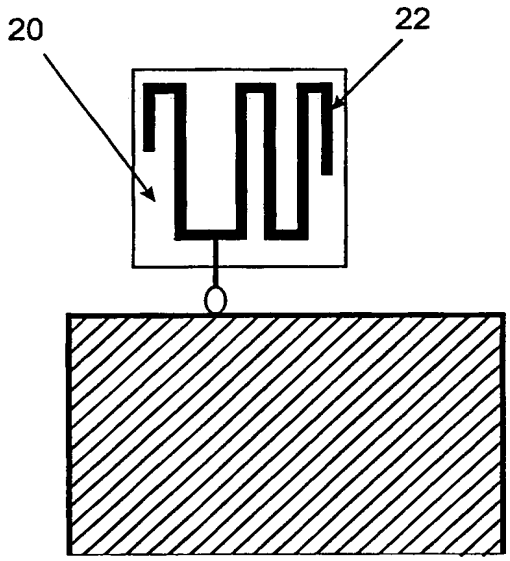


FIG. 3

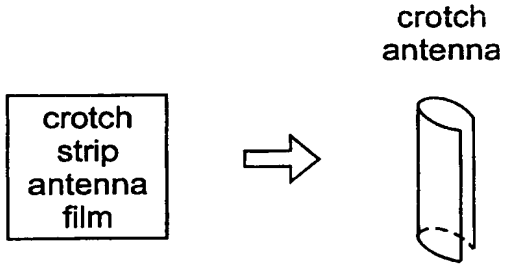
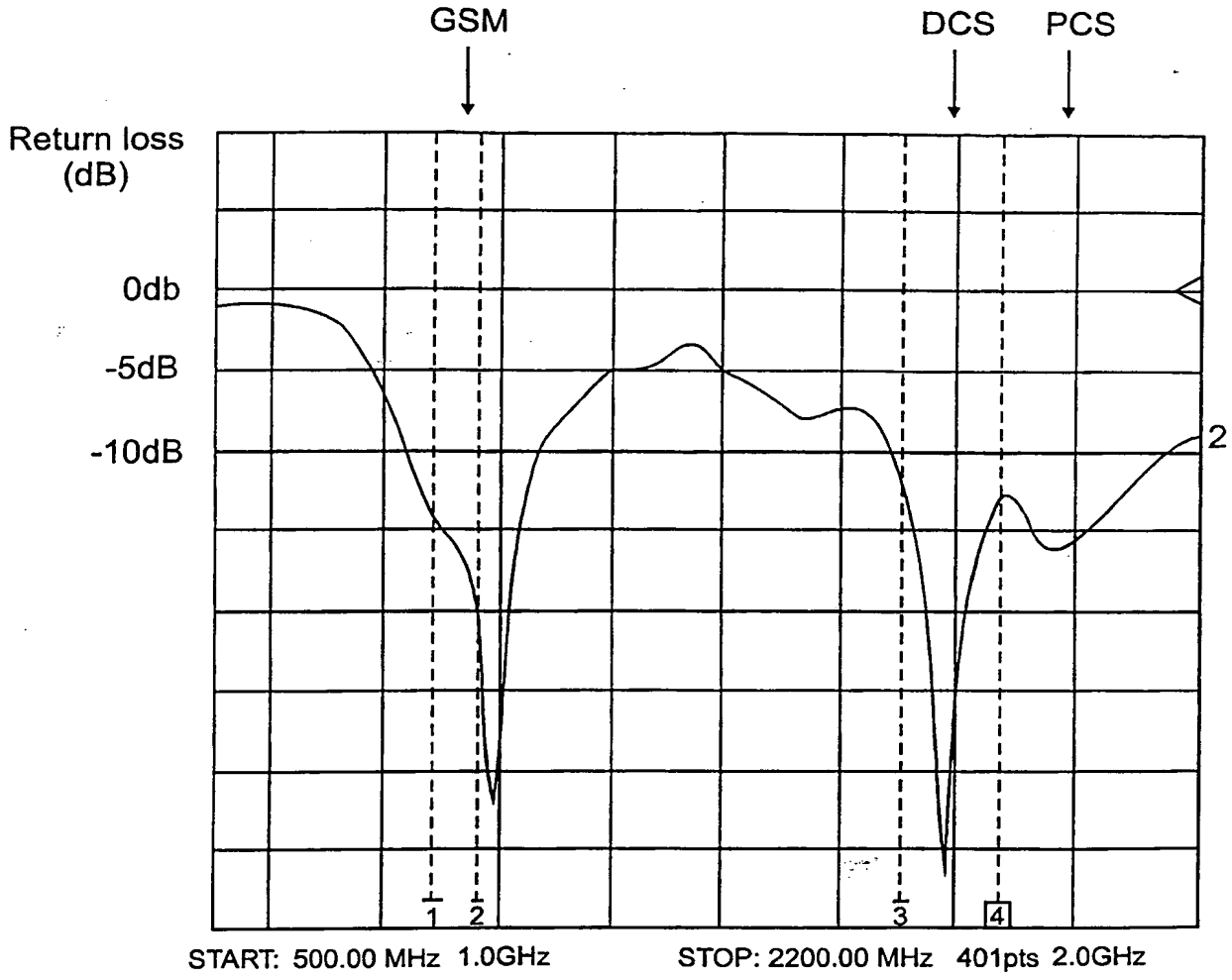


FIG. 4


GSM
DCS
PCS
Return loss
(dB)
0db
-5dB
-10dB
2
1
2
3
4
START: 500.00 MHz 1.0GHz
STOP: 2200.00 MHz 401pts 2.0GHz

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/SE 98/01865

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01Q1/24 H01Q5/00 H01Q9/46 H01Q1/38 H04B1/38

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01Q H04B

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 11507 A (QUALCOMM INC) 27 March 1997 see abstract see page 14, line 10 - page 15, line 29; figures 13,14	1-15, 17-20
X	GB 2 292 638 A (SYMMETRICOM INC) 28 February 1996 see page 6, line 11 - page 7, line 14; figures 1,2	1,5,9,10
X	WO 93 12559 A (SIEMENS AG OESTERREICH) 24 June 1993 see page 3, line 13 - page 4, line 16; figure 1	1,9,11, 19

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[X] Further documents are listed in the continuation of box C.

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P,X	WO 97 49141 A (ALLGON AB ;WASS BO (SE)) 24 December 1997 see page 8, line 20 - page 10, line 10; figures 3,4	1-20
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Information on patent family members

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